streams, introduced by passage through a plate of quartz, only the distance travelled in the second zone is to be taken into account. It may at once be conceded that Jamin's results do not afford a very striking confirmation of Airy's theory, which may in great measure be attributed to the experimental methods that he employed; but M. Quesneville in his criticism does not appear to have sufficiently recognised the distinction between the phase-difference of the streams on emergence into air and that of the rectangular plane polarised components of the resultant elliptically polarised train of waves.

In the second section we have the author's own experimental investigations, that were made with double prisms of quartz cut in different directions with respect to the optic axis and arranged in the shape of rectangular parallelopipeds. When the primitive polarisation is circular, M. Quesneville's theory leads to the same final results as that of Airy, but a divergence occurs when the initial polarisation is plane. Consequently it is found in accordance with both theories that if the light traverse the first prism along the optic axis and its path in the second be inclined to this direction, the emergent pencils can be completely quenched by means of a quarter-wave plate and an analyser; on the other hand, with a pair of prisms, such that the direction of propagation of the light was in the first perpendicular to the optic axis and in the second inclined to it at an angle varying from 5° to 9°, M. Quesneville was unable to obtain complete extinction of the emergent streams either with an analyser alone or with a quarter-wave plate and analyser, whatever might be their orientations. He thence deduced the inference that each pencil is formed of two elliptically polarised streams of opposite rotations that, having traversed the quartz with the same velocity, remain superposed on emergence, and on this experiment he relies for his proof of the four-fold refraction of quartz near the axis. It is noteworthy that this result was only obtained with small prisms, a fact for which a very inadequate explanation is offered.

The last section is devoted to a discussion of the rings produced by plates of quartz in polarised light. Two instances must suffice to show the manner in which Airy's formulæ are treated. On p. 280 it is argued that these would give the so-called quadratic curves even when the initial and final planes of polarisation are parallel, the fact being overlooked that the term that introduces this form of the curves has a factor that is then equal to zero; and on p. 341 the result that in the same circumstances the circles in white light would be black instead of coloured is deduced by equating to zero a sum of essentially positive terms. This section, however, contains several points of interest, the most important being the question whether or no circles exist in conjunction with the phenomenon known as Airy's spirals. In the photographs published in the book these circles do not appear, though they are present in those given by other authors. A question therefore arises as to the accuracy of the plates employed by M. Quesneville, but if his contention be proved it must be recollected that Airy's result is confessedly only approximate, and it is possible that a more complete investigation would lead to a formula giving spiral curves alone.

The book is wanting in the clearness of exposition that we are accustomed to expect from a French writer on a physical subject, and it is a matter for regret that the author, in his anxiety to make a strong case for his own views, should have permitted himself to repeatedly accuse Verdet and other physicists of "prudently passing over in silence" facts that tell against the theory that he is attacking.

ELEMENTARY PHYSICS.

A Text-book of Physics, with Sections on the Applications of Physics to Physiology and Medicine. By R. A. Lehfeldt, D.Sc. Pp. 304; 112 figures. (London: Edward Arnold, 1902.) Price 6*s*.

A COMPLETELY new arrangement has been adopted in this book in the order in which subjects are presented to the student. The traditional order of the text-book of physics has been abandoned, in many cases with advantage, but often a student will be sadly at loss in consequence. He will find it hard to fathom the object of proving (p. 81) that the elasticity of a gas is equal to its pressure before he is familiar with the idea of the elasticity of liquids (p. 85) or of solids (p. 130), and he can derive little help in his efforts by being given for the time being the definition of "constant ratio of stress to strain" when the immediate object is to prove that it is not constant, but equal to the variable p. The study of gases alone would never have suggested attaching importance to the ratio of stress to strain.

Again, to take another example, the subject order adopted involved introducing in connection with conductivity of heat (p. 72) the question of the anomalous expansion of water described later (p. 90).

Likewise, in treating of electrolysis (p. 188), the term electrical charge is used without explanation. In the order adopted this does not appear until p. 249.

Of course, it is not always possible to avoid such anticipations. Students often, however, in consequence fancy they do not understand the point in hand, when it is really the anticipation which is troubling them.

In the order of the chapters, "Heat" comes before "Properties of Fluids," and next comes "Properties of Solids." Sometimes the analogies adopted in consequence come quaintly to one accustomed to the old traditional order of things, and are apt to appear upside down, as the analogy taken from conductivity of heat to help the reader to grasp the idea of flow in liquids.

The work contains a vast number of distinct things for its size. Scarcely any branch of physics is omitted, but it is a question whether there is not too much in the book and whether less matter more carefully arranged would not have better chance of sticking. We must avoid giving our students mental indigestion from overloading. There is an unpleasant feeling throughout of being rather rushed, and that nothing must be left out which the external examiner may perchance alight on in setting the paper. Perhaps the fault, if it be one, may not lie with the book.

The attractions and repulsions of currents appear to be no further alluded to than in the statement describing the Kelvin current balances, that "of the two fixed coils on the right, one attracts the movable coil

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near it, the other repels," leaving the reader to wonder why they do not both attract or do not both repel, or, indeed, why on earth they do either.

The plan of describing instruments and their working instead of the principles involved is to be deprecated in elementary text-books. At the very outset (p. 5) a description of how a tuning-fork is run by an electric current is given, with an explanation of the mode of action which, were it true, would mean that the vibration of the fork could not be kept up by the current. It seems unnecessary at the start to introduce the question at all, but if it must be so, the student should certainly be warned of the necessity of supposing some lag in the current.

One or two serious errors have crept in and must be altered in any future edition. In describing rigidity, the ordinary definition of a simple shear is given, but what follows will certainly bewilder the student.

> "When a pair of steel shears or scissors is used, the force applied is distributed over a very small area, the area of the 'edge' of the shears, so that the shearing stress (per sq. cm.) is great, and the finer the edge the greater the stress becomes; consequently the material so stressed can be cut."

The area here spoken of is at right angles to the area meant in the definition, and in fact has nothing to do with the simple shear. Besides, the action in question is in reality anything but a simple shear.

Another passage requires rewriting. The air supplied to an organ pipe is spoken of as

> "setting in motion a reed fixed in the end, or if there be none, the 'lip' or thin lamina of wood or metal near the front aperture of the pipe."

One misses the old familiar fundamental experiments of the text-books, and in many cases this absence is to be regretted. Thus, at p. 251, the attractions and repulsions of electrified bodies are not described as fundamental observations, but follow as corollaries in rather a cart before the horse fashion from the assumed shortening and swelling of things called lines of force. The student is given a picture of lines of force, and is told that it is "evident that positive and negative charges attract each other."

On p. 233 the metals have got evidently inverted, when it is said that "both soft iron and steel show retentivity, the former to even the greater extent of the two."

It is errors such as these which are just the ones which trouble the student.

From what has been said it might be inferred that the book was found to be without interest; such is not the case. With some alteration it is easy to imagine it made into a thoroughly useful one, especially for medical students, for whom it was more particularly written. The chapter on chemical physics is splendid and forms a most excellent introduction to the subject. The chapter on light is also good. Here the diopter system is introduced with effect; the parts touching on geometrical optics are simply described, no proofs being given. This has much to commend itself in a book of this scope, but at the same time the average student must not be asked to draw conclusions without being carefully given the premisses, as at p. 281, where he is told without further ado that "the distance B F is called the focal length and in case of a mirror is *clearly* half the radius of curvature." A first-class student will see there is something to prove and will prove it; others will not do either. This sort of thing tends in the long run to woolliness in thinking.

The book is well printed and the diagrams are good. There are few misprints; the following, however, were noticed and are given with the view of correction in a future edition. On p. 41, *l.* 32, heads should be altered to beads; p. 60, *l.* 21, 19°·57 to 195°·7; p. 78, *l.* 17, T to P; p. 141, *l.* 35, 0·93 to ·093; p. 267, *l.* 5, E to F.

On p. 180, *l.* 11, 48 watts per hour are spoken of; "per hour" should be omitted.

On p. 240 we find it stated that if a wire of length l be moved across a field of strength H, "the electromotive force due to a motion of 1 cm. will be proportional to lH"; "per sec." has dropped out.

THE VOICE AND RESPIRATION.

Health, Speech and Song. a Practical Guide to Voice-production. By Jutta Bell-Ranske. Pp. 158. (London: Swan Sonnenschein and Co., Ltd.; New York: E. P. Dutton and Co.) Price 4*s.* 6*d.* net.

ALTHOUGH the subtitle of this book is "A Practical guide to Voice-production," the space is chiefly occupied by a description of the organs of voice and respiration, accompanied by statements of the somewhat peculiar views of the author as to the anatomy and physiology of these organs, and criticisms of the views of the many schools of voice-production. There are but a few pages devoted to giving practical instructions on the training of the voice, and what little is said upon this subject is too vague and general to be of much service.

The book throughout is written in a very rhapsodical fashion, so much so that it becomes exceedingly difficult to trace out any meaning in some of its passages, while in other cases the effect produced can only be described as ludicrous.

The following passage may be cited as illustrating this:—

> "Since I have stated that the vocal instrument consists of three elements, it might at first appear that each element must be of equal importance. And if the motor element which drives the organ were given us for the sole purpose of creating song, it would be so, but this element has a far more important function, being the element of life itself; hence song becomes only an overflow of life. Life is breath."

The author repeatedly deplores the ignorance of physiology shown by voice trainers, but the physiological statements made in the book are often very peculiar and occasionally erroneous. Thus it is stated on p. 27 that

> "The diaphragm flattens, that is, is drawn down. The chest is expanded upwards, downwards and outwards, at the expense of the abdomen. The floating ribs, which are attached to the outer rim of the diaphragm, are pressed forward and outwards, thereby greatly expanding the bases of the lungs, an act which constitutes rib or costal breathing."

Other statements in the book (p. 28, *et seq.*) clearly show that the author confuses costal and diaphragmatic breathing, regarding these as identical and to be care-

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